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ABSTRACT

A case study was conducted to seek improved understanding of processes related to teachers' adoption of two classroom-based computer technologies--networked computer-assisted instruction (CAI) and desktop computer multimedia resources--at a selected magnet elementary school. A Stages of Concern Questionnaire was used to gather quantitative data, and interviews with four selected teachers provided qualitative data. The research focused on identifying and describing teachers' self-initiated or voluntary individual and collegial adoption-related activities and on understanding the part such activities played in promoting progression for the innovations through the Concerns Based Adoption Model (CBAM) stages of concern. Qualitative analysis identified two general categories of individual voluntary adoption activities related to several stages of concern including the informational, personal, management, and consequence stages: (1) voluntary investigation of new computer resources (software, devices) for students to use, and (2) voluntary experimentation with altered teaching methods, student work, and classroom physical and procedural arrangements to integrate technology into the learning process. The analysis also indicates increasing collegial interaction among adopting teachers over time related to information, personal, management, consequence, and collaboration concerns. The evolution of teachers' concerns and their voluntary adoption activities are interrelated with their advancing experience with increasingly complex and powerful computer resources over time. An appendix includes the interview script. (Contains 50 references.) (Author/SWC)

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ADVANCED ADOPTION OF COMPUTER TECHNOLOGY IN THE CLASSROOM AND TEACHERS' PARTICIPATION IN VOLUNTARY INNOVATION ADOPTION ACTIVITIES

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ABSTRACT

The purpose of the case study discussed here was to seek improved understanding of processes related to teachers' adoption of two classroom-based computer technologies: networked CAI and multimedia resources, in terms of the CBAM stages of concern theory at a selected magnet elementary school. The research focused on identifying and describing teachers' self-initiated or voluntary individual and collegial adoption-related activities and on understanding the part such activities played in promoting progression through the CBAM stages of concern for the innovations.

A combination of quantitative and qualitative methods was used in the descriptive, exploratory research design. Quantitative data was obtained through use of the Stages of Concern Questionnaire (SoCQ). Qualitative data was gathered via informant interviews with four selected teachers, those with the most advanced concerns profiles of the total teacher group (n=19). The research provided a contextual description of the adoption situation, identified informant interviewees who demonstrated advanced patterns of concerns regarding the technology innovations, sought qualitative information from the interviewees about their adoption activities and experiences, and related those activities and experiences to the CBAM stages of concern. Interview data was subjected to content analysis to identify categories of statements and statement groups pertinent to stages of concern.

Qualitative analysis identified two general categories of individual voluntary adoption activities related to several stages of concern including the informational, personal, management, and consequence stages. These categories were: 1. Voluntary investigation of new computer resources (software, devices) for students to use and, 2. Voluntary experimentation with altered teaching methods, student work, and classroom physical and procedural arrangements to integrate technology into the learning process. The analysis also indicated increasing collegial interaction among adopting teachers over time related to informational, personal, management, consequence, and collaboration concerns. The evidence indicated that the evolution of teachers' concerns and their voluntary adoption activities were interrelated with their advancing experience with increasingly complex and powerful computer resources over time.

These results indicate that interrelated individual and collegial voluntary adoption activities by teachers in this case, associated with an expanding repertoire of concerns developed in response to their increasing knowledge and evolving interpretation of complex computer innovations, supported the teachers' advanced adoption of the technologies into teaching and learning in the classroom.

Advanced Adoption of Computer Technology in the Classroom and Teachers' Participation in Voluntary Innovation Adoption Activities

The purpose of the case study discussed here was to seek improved understanding of processes related to teachers' adoption of two classroom-based computer technologies: networked CAI and multimedia resources, in terms of the CBAM stages of concern theory (Hall and Hord, 1987) at a selected magnet elementary school. Computer technologies had been introduced in the school over a period of seven years, beginning with relatively simple CAI applications and progressing to substantially more sophisticated and complex resources over time. The research focused on identifying and describing teachers' individual and collegial adoption-related activities and on understanding the part such activities played in promoting progression through the CBAM stages of concern for the innovations. Particular research interest addressed self-initiated or voluntary innovation adoption activities.

Background

Throughout the twentieth century, many efforts to reform education have involved attempts to introduce technological innovations into the classroom. Teacher resistance to adopting technologies in the classroom has been a principal stumbling block to many innovations for education reform. This problem is amplified in its contemporary consequences by the rapid advance of sophisticated computing and communication technologies available to education.

Much of the failure of educational technology innovation has been associated with resistance of teachers toward adopting technologies and integrating them into their teaching practices (e.g., Cohen, 1987, 1988; Cuban, 1986; Hodas, 1993; Kerr, 1990, 1991). The reluctance of teachers to adopt educational technology has resulted in expenditures of vast sums

on unused, underutilized, or misapplied technologies and the loss of opportunity to apply these innovations effectively to educational reform.

New, computer-based technologies such as wide-area telecommunication and desktop multimedia have emerged in recent years, joining with increasingly sophisticated computer assisted instruction systems, providing expanding potentialities for restructuring educational practice (e.g., Collins, 1991; Newman, 1992; Papert, 1993; Sheingold, 1991). However, continuing failure to overcome technology rejection at the classroom level will result in further loss of reform opportunity and continued waste of substantial funding.

One recurrent focus of attention in technology innovation has been the training and development of teachers to support and encourage adoption. Traditional approaches to training have been narrowly directed toward developing teachers' technical knowledge and skills for the operation and management of technologies. These methods have generally proven to be ineffective in bringing about successful adoption of technologies in the classroom (Hall and Hord, 1987; Hoth, 1985; McMeen, 1984; Wedman, Heller, and Strathe, 1986). Experience and research in recent years have led to an alternative perspective which suggests that teachers' adoption of technologies in the classroom involves more than the mere acquisition of necessary technical skills and information. In this perspective, technology adoption is seen to involve the alteration of often deeply held beliefs and values regarding teaching methods, education, and the proper roles of teachers and students. Such methodological, philosophical, and cultural changes have been extremely difficult to effect in relation to educational technology innovation (Cohen, 1987, 1988; Cuban, 1986; Hodas, 1993).

In several recent school change projects involving technology (e.g., Sandholtz, Ringstaff, and Dwyer, 1991), successful innovation has been seen to involve teachers' voluntary engagement in adoption related activities. In these instances, teachers have been observed to promote their own methodological and attitudinal changes through participation in both individual and collegial actions at their own volition. These activities were initiated by the teachers themselves as they progressed through a developmental change process. Sandholtz et al. reported that teachers' engagement in collegial interactions related to technology adoption demonstrated a developmental progression through several cumulative stages. These stages addressed, in order from earliest to last, the issues of: 1. Emotional Support, 2. Technical Assistance, 3. Instructional Sharing, and 4. Collaboration. While these observational findings indicated the potential importance of self-initiated activities in technology adoption, they were not interpreted in relation to formal theories of change or of innovation adoption and diffusion.

One theoretical model of adoption that has given a central place to the concept of developmental teacher change in educational innovation is the Concerns Based Adoption Model (CBAM). CBAM, developed by the Research and Development Center for Teacher Education in Austin, Texas (Hall and Hord, 1987), proposes that adopters of innovations progress through a predictable sequence of "concerns" as they acquire increasing familiarity with an innovation and skill in its application. The developmental CBAM model proposes a sequence of seven specific concerns through which adopters progress over time. Adopters advance from early occurring concerns about self-oriented issues (Awareness, Informational, and Personal concerns) to intermediate occurring task-related concerns about effective management and use of the innovation (Management concerns), and eventually to concerns for the impact of the innovation

on students (Consequence, Collaboration, and Refocusing concerns). The model is developmental in that it proposes a characteristic predictable order of emergence of these concerns and theorizes that earlier concerns will, in general, subside in intensity before later concerns are aroused. Therefore, more advanced users of an adopted innovation will demonstrate distinctly different patterns of high and low intensity concerns (concerns profiles) from those of relative novices. CBAM theory proposes that change interventions, including teacher training, will be more effective if they address the concerns predominant in teachers regarding an innovation at the time of the intervention.

It can be noted that the Sandholtz et al. (1991) categories of teachers' collegial interactions demonstrate a pronounced similarity in description and sequence to the middle-range concerns of the CBAM Stages of Concern model, with the omission of the earliest two and last concerns. Table 1 demonstrates the parallel in developmental sequence of the categories of collegial activity from Sandholtz et al. and the comparable stages of concern according to Hall and Hord (1987).

Table 1

Comparison of Collegial Interaction Categories and Stages of Concern

Sandholtz et al. Collegial Interaction Categories	CBAM Stages of Concern	CBAM SoC Type
Emotional Support	(2) Personal	Self
Technical Assistance	(3) Management	Task
Instructional Sharing	(4) Consequence	Impact
Collaboration	(5) Collaboration	Impact

Sandholtz et al. (1991) did not relate the CBAM stages of concern model to their research findings. However, the similarity between the descriptions and sequential orders of the collegial interaction categories and CBAM stages of concern raises the question of a possible relationship between teachers' collegial interactions and related individual voluntary adoption activities and their developmental advancement through the concerns sequence.

However, a significant distinction may be noted between the progression of collegial interactions and that of the CBAM stages of concern sequence. The collegial categories accumulated over time. Once a category of interaction (e.g., Emotional Support, Technical Assistance) entered into the collegial process, it remained in the repertoire of interactions thereafter as adoption advanced over time and as later categories emerged. This differs from the CBAM stages of concern model in which it is theorized that, generally, earlier concerns will diminish in intensity as they are resolved by adopters and will be replaced by the experience of later concerns which emerge and increase in intensity until they also are, in turn, resolved.

The Study

The case research discussed here addressed the role of teachers' voluntary adoption activities in relation to their advancement through CBAM concerns regarding adoption of two classroom-based computer technologies: networked computer-assisted instruction (CAI) and desktop computer multimedia resources. This discussion pertains to the following research question:

Have voluntary adoption activities, as reported in interviews by teachers demonstrating the most advanced CBAM concerns profiles based on SoCQ scores, contributed to those teachers' advancement through the stages of concern sequence with respect to either CAI or multimedia technology?

A combination of quantitative and qualitative methods was used in the descriptive, exploratory research design (Wesley, 1996). Quantitative data was obtained through use of the Stages of Concern Questionnaire (SoCQ) (Hall, George, and Rutherford, 1977; Hord, Rutherford, Huling-Austin, and Hall, 1987). Qualitative data was gathered via informant interviews with four selected teachers, those with the most advanced concerns profiles of the total teacher group (n=19). The research provided a contextual description of the adoption situation, identified informant interviewees who demonstrated advanced patterns of concerns regarding the technology innovations, sought qualitative information from the interviewees about their adoption activities and experiences, and related those activities and experiences to the CBAM stages of concern. Interview data was subjected to content analysis to identify categories of statements and statement groups pertinent to stages of concern (Wesley).

The evidence of this case study indicated that both individual and collegial voluntary adoption activities of the teachers interviewed had been an integral and essential part of the technology adoption process. Furthermore, these interrelated activities had been associated with the teachers' emerging and evolving CBAM concerns related to computers in the classroom. Their adoption activities also interacted with teacher training, the change strategy employed, and the complexity of the innovation.

Working individually, teachers pursued self-initiated adoption-related activities which fell into two categories: (a) investigation of computer resources and their uses, and (b) experimentation with classroom procedures related to integrating computer applications into teaching practice. Their investigative activities led to increased personal knowledge of the availability and applicability of instructional computer programs and other computer applications for their students' use. Their experimentations led to extended and refined utilization of computers in the classroom. Teachers' descriptions of individual adoption activities demonstrated evidence of their association with CBAM concerns ranging from the Informational to the Consequence stage.

Teachers' individual adoption activities were closely interwoven with their collegial interactions. Statements such as, "When somebody learns something new, we share it," and ". . . If you find something, share it, it's too good to keep to yourself . . ." illustrate a unity of individual and collegial activity in these adopters' experience. Collegiality was also related to a wide range of CBAM concerns. Collegial interactions pertained to basic information about computer resources, emotional support, efficient management of computers in the classroom, effects of computers on student learning, and collaborative endeavors, reflecting concerns extending from the Informational to the Collaboration stages..

A non-coercive, facilitative organizational strategy for change allowed teachers to pursue highly individualized approaches to adoption at their own pace and under their own control. Self-initiated adoption activities were supported by the training the teachers received. Training, mainly directed at Informational and Management concerns, set in motion change processes which the

teachers sustained and extended as they voluntarily pursued their investigative, experimental, and collegial activities related to technology use.

The development of teachers' concerns was related to the increasing technical and operational complexity of the computer technologies available to them over time, as well as to teachers' advancing experience with the innovations. The advance in complexity of their computer resources provided teachers with increasingly flexible and powerful tools which they could adapt to their teaching on an ad hoc basis more readily than they could the relatively simple and inflexible applications of earlier CAI. Increasing complexity of available technologies had encouraged increased individual investigative and experimental activity on the part of teachers. Teachers also indicated that the increasing complexity of their more recent and more sophisticated resources gave them "more to talk about" compared to the relatively simple earlier technologies, motivating increased collegial interactivity about their use of technologies.

With increased experience, teachers developed and addressed advanced impact-related concerns pertaining to familiar applications of computers in the classroom. Also with advancing experience, newly encountered applications of computers and evolving interpretations of the innovations refreshed and sustained self- and task-related concerns as well. Teachers' continuing and escalating individual and collegial activities, related to an expanding repertoire of active concerns, facilitated the advance of their knowledge of the technologies and their integration of them into teaching practices, thereby promoting successful adoption.

The findings of this study support the general developmental conception of change related to adopters' concerns as proposed by CBAM theory. However, the findings indicate that an expanded theoretical model is required to accommodate the role of teachers' voluntary activities

in the adoption of complex educational technologies. The model which emerges from this study modifies the sequential CBAM conception of concerns advancement. This modification integrates voluntary adoption activities with the maintenance of elevated early concerns as adoption advances.

Discussion

The relationship between teachers' concerns and their voluntary adoption activities is complex. Individual and collegial adoption activities have addressed a range of identifiable concerns in the teachers' experience. With increasing familiarity with computer technology, the teachers have developed Impact concerns for Consequence and Collaboration as expected under CBAM stages of concern theory. Even while enacting adoption activities related to such impact-related concerns, the teachers have continued to respond to concerns at the self- and task-related levels as well. This maintenance of early concerns appears to be related to the teachers' evolving experiences and changing interpretations of the increasingly complex computer technologies available. As they have advanced in knowledge and acceptance of more sophisticated and flexible technologies, they have encountered new experiences and interpretations of them which have sustained early concerns.

The findings of this exploratory case study were generally consistent with those of the series of studies by J. H. Sandholtz, C. Ringstaff, and D. Dwyer published in 1991. Their studies addressed the adoption behavior of teachers in "immediate-access-to-technology classrooms" (Sandholtz, et al., 1991, p. 2). Their research situation was characterized by the simultaneous implementation of a wide variety of advanced technologies, including computer-networked communications systems, and by intentional efforts to encourage collaborative interaction. In

contrast, in the present study the installation of technologies has progressed from relatively simple computer resources to more complex systems over a period of seven years. While teachers have been trained in the basic use of the technologies and in methods of integrating them into the classroom, no special efforts have been taken to induce collegial interaction specifically related to technology beyond incidental occurrence in grade level teachers' meetings. Yet, despite these disparities between the Sandholtz et al. studies and the present study, the development of individual and collegial adoption activities by teachers appears to have followed similar courses in the two situations. The occurrence of voluntary individual investigation and experimentation by teachers and of collegial interactions to share support and information has progressed from limited and sporadic actions to frequent and consistent activities, eventually becoming integral with the continuing advancement of technology adoption.

Results of the study were also consistent with the findings and interpretations of Wedman (1986) and Wedman et al. (1986). In their reports, early occurring concerns persisted at high intensity even after teachers experienced elevation of later concerns. Wedman et al. suggested two interrelated explanations for this effect. First, the maintenance of relatively intense early concerns accompanying the development of later concerns may result from the introduction of a progressive series of different applications of a complex technology. This explanation is consistent with the present study. Over the years, the installation of technologies in this case has been enhanced by the introduction of more and more powerful, flexible, and varied computer-based resources. This explanation, and the present findings, are also consistent with CBAM theorists' observation that, "In addition to changing developmentally, [concerns] will recycle in response to each new innovation or even to phases of an incremental innovation" (Hord et al., 1987, p. 43).

The second explanation by Wedman et al. (1986) is also relevant to the present situation. Maintenance of early concerns may result from progressively changing perceptions or interpretations of a complex technological innovation by adopters as they experience emerging aspects of it. Such changing interpretations of educational computers are evident in the reports of teachers in the present study. From initially interpreting computers as suited only for specific, limited, and peripheral educational applications, they have come to see them as powerful, flexible, and adaptable resources appropriate for full integration into classroom learning activities. This progression of interpretations has been experienced by all of the teachers interviewed, regardless of their initial attitudes about computers. The process of reinterpretation has been related to the increasing power and complexity of the available technologies as well as to teachers' advancing experience with them. The technologies have come to be of sufficient complexity to present emerging characteristics to the teachers as they have learned more and more about them. In effect, as suggested by Wedman et al., the adopters have changed and the innovation has changed.

This process of mutual transformation has also been integrally related to the increase in voluntary adoption activities by the teachers and to their ongoing experience of concerns. As the resources have advanced in flexibility and power, teachers have come to perceive them as offering a broader range of educationally valuable aspects, appealing to their concerns for the consequences of the innovation for their students. This has motivated teachers to engage in individual searches for additional programs (Informational concerns) and for knowledge of how to apply them in the classroom (Management concerns). Their increasing knowledge, and desire for more knowledge, related to Informational, Personal, and Management concerns, have motivated increased collegial sharing of information and support. Based on their self-reports, it appears that

the teachers' concerns for consequences of the innovation and for collaboration through collegial interaction were intermeshed with Informational, Personal, and Management concerns, all of which have acted in concert to motivate voluntary adoption activities. Teachers' volition in initiating and sustaining voluntary adoption activities has been integral with their individual and shared experiences of a sequential accumulation of concerns about the innovation.

The findings of the present study bridge the theoretical CBAM stages of concern model and the Sandholtz, Ringstaff, and Dwyer (1991) categories of collegial interaction (and related individual activities). Teachers' reports reflect a developmental sequence parallel to both the CBAM and Sandholtz et al. models while demonstrating the maintenance of earlier concerns along with the occurrence of later concerns. Consistent with the explanatory suggestions of Wedman (1986) and Wedman et al. (1986), this result can be related to adopters' evolving experience and interpretations of complex technologies. Sandholtz et al. (1991) commented that, "Those searching for a way to assess the impact of innovation should not expect to see a clear progression through stages. Problems of implementation and adoption may arise, disappear, and reoccur as teachers and students adjust to the innovation" (p. 24). In addition to the effect of such "problems", the present results indicate that positive, productive processes of change associated with voluntary adoption activities may also complicate the straightforward progression of adopters through developmental stages.

Based on this study, the theoretical developmental sequence of CBAM can be reconceptualized. Adoption in the present study demonstrates a developmental process related to the stages of concern sequence. However, the various concerns evident in teachers' reported adoption activities have developed and maintained interaction with each other throughout the

adoption process. Voluntary adoption activities initially motivated by early concerns have been sustained and even increased by the emergence of later concerns. For instance, collegial interactions originally initiated by teachers in search of personal emotional support have been maintained later in the adoption process to share their discoveries of new ways to apply innovations. Conversely, emerging reinterpretations of complex innovations, experienced as new innovations, have refreshed and sustained early concerns and their motivational force, further driving voluntary adoption activities. Among these teachers, the total repertoire of adoption activities and experienced concerns has been expanded over time in a more and more strongly interwoven matrix.

This revised theoretical conception of the adoption process moves beyond a linear, sequential model of developmental change. In this case, it represents a more complex developmental process in which teachers' adoption activities have been interrelated with an expanding repertoire of experienced concerns and with contextual features including the adoption environment, training interventions, organizational change strategy, school culture, and the complexity of the innovation. This adoption process does not have a definite end, but continues on as a growth process for both the individuals and the organization. The adoption process demonstrates a continuing evolution of the perceived characteristics and consequences of the innovation related to the ongoing growth of the adopters with respect to the innovation.

Traditionally, planned change in innovation adoption has been conceptualized as a mechanistic activity of intervention and response working through a sequence from start to completion. In contrast, the theoretical conception presented here is one of emergent growth resulting from a complex synergy of interacting components continuing indefinitely through time.

The result of this complex process is a transforming school organization in which the innovation is increasingly and dynamically integrated into the fabric of the social system.

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APPENDIX A

INTERVIEW SCRIPT

Interview comments:

1. **I am doing research for my dissertation related to teachers and their use of technologies in the classroom. I chose this school because of its tradition of use of technologies. My emphasis is on teachers' experiences with coming to make use of technologies. I will be asking you questions about your observations and thoughts about this topic.**

2. **As I mentioned in the letter I sent you, all information produced by this study will be confidential and not reported in an individually identifiable manner.**

3. **I would like to record what you tell me so I don't miss any of it. My study will involve analysis of your statements and I don't want to take a chance on getting your statements wrong. So if you don't mind, I will use the recorder to make sure I get an accurate record.**

4. **You will notice that I am going to refer to my notes when I ask some questions. This is so that I will ask them in very nearly the same way to each teacher.**

5. **Do you have any questions for me before we begin?**

Interview Questions:

1. I want to begin by asking you about the computer technologies you use in your classroom. Would you describe what technologies you use the most and generally survey how you now use these technologies?

2. Tell me how you determine which technologies to use for various activities or purposes.

3. So you now use technologies for (**review the purposes**). Now I would like to ask you some questions about how you have come to make these uses of technology. First of all, would you tell me about the training and development experiences you have had related to the various technologies you use. What training activities have you participated in and when did they occur?

4. How was this training most beneficial to you (**review specifics if necessary**)?

5. How would you describe your attitudes toward computer technologies in the classroom prior to your earliest training on them?

6. In what ways did the training affect your attitude or feelings toward classroom computer technologies (**seek examples**)?

7. So the earliest training you had was (**earliest training**). Was that the first time you dealt with computer based technology in your teaching career or had you encountered it previously?

8. I would like to ask you to think back to the time just before you began to make use of computers in your classroom. Describe for me what I would have seen if I had come into your classroom during a typical class on a typical day.

9. If I visit a typical class session in your room today, what would I see and how is it different from before?

10. How would you relate the changes you describe in your classroom situation to your use of technologies?

11. Since you first began to use computers in your classroom, how has your use of them changed?

12. Tell me about when you made these changes (**cite details**) and how the changes occurred. Describe the ways in which these changes you describe came to be.

13. What have been the main benefits to you of making these changes?

14. Which of these changes in your use of technologies you describe have occurred mostly due to training or other outside interventions and which would you say you made mainly on your own?

15. What would you say were your main reasons for making the changes you have made on your own?

You have told me about your individual work with classroom computers, Now:

16. I would like you to tell me something about the working relationships between teachers here. Describe any ways that teachers work together, rather than individually.

17. How would you say teacher interaction has changed during the time you have been at this school?

18. How are shared activities of teachers related to their uses of classroom computer technologies?

19. Can you give me some examples of such shared activities you have participated in?

20. How were these shared activities initiated?

21. What would you say motivated you and the other teachers to initiate or participate in these shared activities?

22. What would you say were the main benefits to you of participating in these shared activities?

23. What shared activities are occurring now on a fairly regular basis?

24. How are current interactions among teachers in relation to classroom technologies different from those in the past?

25. What additional interactions between teachers would you like to have happen in the near future?

26. How would these be different from past or present interactions?

Let me return now to your own classroom uses of technologies:

27. What further changes would you like to make in your own uses of classroom computer technologies in the near future?

28. What would be the benefits of these changes for you?

29. You see the sort of individual experience of teachers I am interested in knowing about. Is there anything about your own experience with or attitudes toward classroom technologies that you think I should ask about or that I should take into account that I haven't?